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RESULTS OF THE COAST GUARD'S TARBALL SAMPLING PROGRAM.(U)
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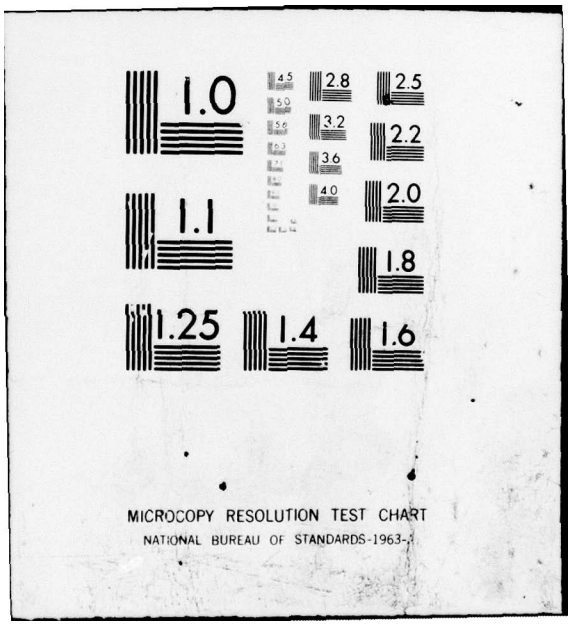
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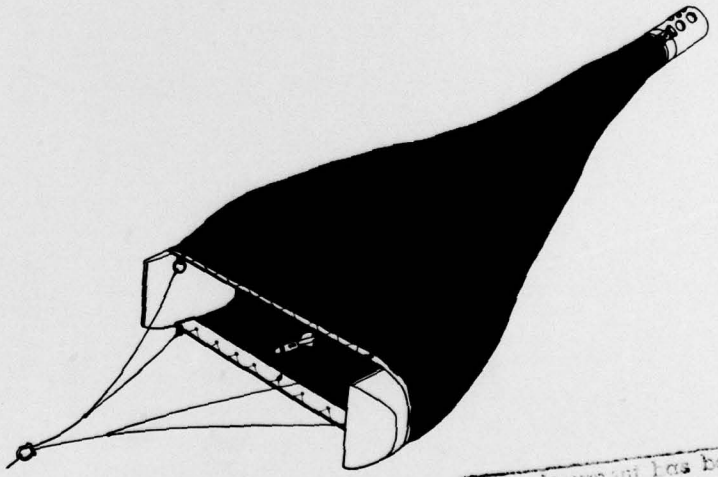
COAST GUARD

LEVEL II

RESULTS OF THE COAST GUARD'S TARBALL SAMPLING PROGRAM



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16. Abstract

The U.S. Coast Guard has been conducting a tarball sampling program since December 1971 and to date over 1000 tows have been made. These tows have been made in the North Atlantic Ocean, the Labrador Sea, Gulf of Mexico, North Pacific Ocean, Bering Sea and the Gulf of Alaska. In general, low tar concentrations are found in the polar area, the average concentration being less than 0.03 mg/ sq. m., and can probably be attributed to the small number of natural seeps and limited amount of man's activities in these areas. High average concentrations (greater than 1.65 mg/ sq. m.) were found in the North Atlantic and North Pacific Oceans and the Gulf of Mexico where man's activities in the form of both drilling and shipping are greater.

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(6) *RESULTS OF THE COAST GUARD'S TARBALL SAMPLING PROGRAM*

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ABSTRACT

The U.S. Coast Guard has been conducting a tarball sampling program since December 1971 and to date over 1000 tows have been made. These tows have been made in the North Atlantic Ocean, the Labrador Sea, Gulf of Mexico, North Pacific Ocean, Bering Sea and the Gulf of Alaska. In general, low tar concentrations are found in the polar areas, the average concentration being less than 0.03 mg/m^2, and can probably be attributed to the small number of natural seeps and limited amount of man's activities in these areas. High average concentrations (>1.65 mg/m^2) were found in the North Atlantic and North Pacific Oceans and the Gulf of Mexico where man's activities in the form of both drilling and shipping are greater.

Table of Contents

List of Illustrations

INTRODUCTION

Tarballs are lumps of weathered petroleum products which are found floating on the sea surface. The origin of tarballs have been attributed to both man-made oil spills and natural crude seepage. General reviews of the subject include those by Butler, Morris and Sass (1973), Butler (1975), and National Academy of Sciences (1975). For several years the U.S. Coast Guard has been involved with collecting samples of this oil residue. The goal of this program was to learn something about the distribution of tarballs and obtain baseline data on their concentration in the ocean so that long term trends could be observed. This monitoring of long term changes would provide an evaluation of the effectiveness of control measures in oil transportation (by water) and offshore drilling.

EQUIPMENT AND PROCEDURES

Data for the tarball program were collected by tarball tows conducted from Coast Guard cutters. The program was started in December 1971, and over 1000 tows have been made. The tows were made daily when a ship occupied an Ocean Station or when on fisheries patrol, on a not-to-interfere with primary mission basis. In addition, tows were taken on special cruises as directed by Area Commanders. The equipment utilized consisted of a Neuston net (Fig. 1) attached to a towing frame developed at the Coast Guard Research and Development Center, Groton, Connecticut. The net and frame were attached to a boom aboard the ship by a wire harness. A propeller-type, digital flow meter was hung in the mouth of the net to measure the horizontal distance of the tow.

Tows were generally made at 3 knots or less for a duration of between 45 to 60 minutes. Tarballs were separated by hand from any other material collected during the tow. Then they were sent to the Coast Guard Oceanographic Unit where they are presently in storage. Additional measurements made while conducting the tow were sea surface and air tempertures, wave/swell height and direction, and wind speed and direction. The tarballs were weighed at the Oceanographic Unit, and the concentration of tarballs on the sea surface (in mg/m^2) was calculated. These measurements were entered in a data log along with the ship's name and cruise designation, the location and time of the tow, and other environmental information and were submitted to the National Oceanographic Data Center (NODC).

The data have been separated into four geographic locations: 1) The North Pacific Ocean and adjacent areas, 2) The Gulf of Mexico, 3) The North Atlantic Ocean and adjacent areas, and 4) Ocean Weather Station Hotel. The data for the North Atlantic and Pacific Oceans was further broken down by location. A $5° \times 5°$ grid was utilized as the division of each locale. For the Gulf of Mexico a $2° \times 5°$ grid was used due to the much smaller area of the Gulf. The concentration of tarballs (mg/m^2) was found in each grid giving some indication of the quantity of petroleum residue present.

Due to the large number of tows made at OWS Hotel and their continuity, it provided an ideal location to observe variations in tarball concentration. Both seasonal change and those due to differing water masses and sea currents were examined. The data were grouped into four three-month seasons. Winter spanned December through February; Spring, March through May; Summer, June to August; and Fall, September through November. Again the concentrations in each season were averaged.

NORTH PACIFIC OCEAN AND ADJACENT AREAS

Several observations can be made and others deduced from the data thus far collected by the Coast Guard in the tarball program.

It was found that the concentration of tarballs in the Gulf of Alaska was very low. With nearly two hundred tows made in the Gulf of Alaska, the tarball concentration averaged less than 0.03 mg/m^2 of sea surface area (Fig. 2). There are numerous natural seeps along the coast of Alaska which may account for a substantial amount of these tarballs. With the opening of the Alaska Pipeline, and the resultant increase in tanker traffic through these

waters, the Gulf of Alaska can serve as an ideal laboratory to accurately monitor the effect of oil transport through this region.

The Bering Sea had an even lower concentration of tarballs than did the Gulf of Alaska. This may be attributed to the few natural oil seeps along its coastline and to the fact that ship traffic is nearly nonexistent in this region. Twenty-three tows were made in the Bering Sea and of these only one tow recovered any tarballs. The concentration of tarballs on that tow was .009 mg/m^2.

Throughout the North Pacific Ocean tarball concentrations in the various grid areas fluctuated widely (Fig. 2) from 0.0 to 3.3 mg/m^2. Few of the areas, however, had more than five tows made within their boundries. Those areas with high concentrations generally had one or two tows with much larger values than the rest, and thus their high averages may be due to anomalies. The average concentration for the North Pacific Ocean was about 1.25 mg/m^2. Typically there were high concentrations between the Hawaiian Islands and the west coast of the United States which may be a result of commercial traffic through this area.

GULF OF MEXICO

In the summer of 1975 and winter of 1976 the USCGC ACUSHNET made oceanographic cruises in the U.S. coastal waters of the Gulf of Mexico. During each of these cruises, tarball surveys were conducted at 44 and 45 locations respectively. This gave a reasonably synoptic picture of the tarball concentrations in these waters.

The Gulf of Mexico was also found to have a fairly high overall tarball concentration, about 1.45 mg/m^2 (Fig. 3). It was not constant throughout the Gulf but increased from east to west. Charles W. Morgan (personal communication) showed that this may have some correlation with offshore oil drilling. Morgan also described how the currents of the Gulf will tend to sweep material rapidly into the area along the Texas coast and then let it accumulate as the water slows down. Koons and Monaghan (1976) indicate that the shelf area of the southwestern area of the Gulf is a region of high seepage potential which may account for many of the tarballs throughout the Gulf.

NORTH ATLANTIC OCEAN AND ADJACENT AREAS

The Labrador Sea is another region of very low tarball concentration. The area along the northeastern coast of Newfoundland was sampled by 3 tows with an average tarball concentration of <0.01 mg/m^2 indicating a fairly stable condition. Any increase in tarball concentration in this region would tend to indicate that man-made oil spills or dumping was responsible since this area is becoming increasingly important in the search for oil.

The North Atlantic Ocean was an area of extreme fluctuation in tarball concentration from one grid area to another (Fig. 4). Although some areas were sampled very heavily, there was a large area at midocean that was never sampled. From the data which was taken, it may be concluded that along the northern half of the U.S.'s eastern seaboard the tarball concentration is higher than in other observed areas of the North Atlantic perhaps due to the tremendous amount of commercial traffic, including tankers, through the area. The currents in this area tend to bring tarballs from other regions to this area resulting in higher tarball concentrations. The average concentration for the North Atlantic Ocean was about 1.65 mg/m^2 although some grid areas had concentrations of greater than 8 mg/m^2.

OCEAN WEATHER STATION HOTEL

The data for OWS Hotel, as previously mentioned, were grouped by season. It was found that the tarball concentration can vary tremendously over a 24 hour span, even if two successive tows were made in the same water mass. In one instance during November 1975, the observed tarball concentration went from 0.0 mg/m^2 on the 25th to 320.7 mg/m^2 on the 26th! Sea state conditions, water temperature, etc., remained constant over the period.

One particular three week span, November 19th to December 12th, 1975, had an average tarball concentration three orders of magnitude over the usual November/December average. A system of two warm-core eddies entered the region during the time and may have carried the tarballs responsible for this anomaly from the Sargasso area but positive correlation is not possible.

The relatively high average concentration of 7.996 mg/m^2 and large standard deviation of ± 45.475 may be a biased number due to the nature of the operations on OWS Hotel. Basically the ship remained in the area of a circle with a 15 nautical mile radius while occupying OWS Hotel which meant the ship was often drifting. It therefore may well have been that the personnel conducting the tows were looking for tarballs and made a conscious effort to collect tarballs. One tow had a concentration of 639.351 mg/m^2 which in it self is

enough to raise the average weight by almost 2 mg/m². The large standard deviation is indicative of the large spread in observed valves. By contrast, the average concentration for the 5° × 5° grid that OWS Hotel is located in was only 1.172 mg/² with a standard deviation of ±0.235. These latter numbers were arrived at by excluding the OWS Hotel data.

A final observation to be made at OWS Hotel was that the tarball concentration did vary seasonally. It was lowest in the winter season and generally highest in the summer, although the tarball concentration can be large in the fall or spring as well. The winter season at OWS Hotel was usually the period with highest sea state and the greatest winds which would induce mixing of the surface waters to greater depths. This would tend to make values from samples collected during this period lower than in periods of smaller seas and lesser winds.

CONCLUSIONS AND RECOMMENDATIONS

In general, low tarball concentrations were found in the polar regions. This can probably be attributed to the limited amount of man's activities and fewer number of natural seeps in these areas. Certainly these would be areas that would require watching over the next several years.

Areas of the heaviest tarball concentration appear to be in areas of high commercial traffic, although high traffic areas generally coincide with areas where extensive drilling is taking place, so caution must be used when drawing conclusions. Areas along both the east coast and west coast of the United States fall into this category.

Due to the crude nature of sampling for tarballs, the data presented is only representative of the tarball concentration in the region. The more tows that are taken, the more confidence that can be put on the numbers associated with the concentration.

There are improvements which might be made with the sampling techniques. High tarball concentrations have been found in wind rows (Langmuir cells) and if the sampling happens to be done between wind rows as opposed to along or across wind rows, the results would be expected to differ considerably. One possible solution to help eliminate this bias would be to sample in a trackline perpendicular to the wind. This would tend to cut across wind rows giving a more representative sample.

More emphasis should also be given to describing the hardness, texture, color, and sizes of the tarballs collected. When stored in jars, the tarballs tend to lose their identity. These better descriptions would give some insight into the age and possibly source of the tarballs.

There are still areas in the middle of the Gulf of Mexico that have not been sampled under this program. Special attention would have to be given to the water mass being sampled during the tow to determine whether the collected samples originated in the Gulf of Mexico or are being carried through by the Loop Current.

There have been a fair number of tows taken in the Gulf of Alaska, an area that bears future watching. An increase in the tarball concentration in this area could be indicative of the increase in petroleum transportation and the need for stricter guidelines and/or enforcement of pollution regulations. Similarly, continued monitoring of the polar regions in the western North Atlantic Ocean is necessary to evaluate the fate of that region.

Finally, emphasis should be put on sampling in those areas where there is little or no information now available. The chemical analysis of tarballs would give some insight into the origins and possibly age of the tarballs by looking at the hydrocarbon fractions and trace elements. However, due to the large number of samples collected and the expense involved in the analysis, only selected samples could be analyzed. Only through diligence can changes in concentration be detected and this is necessary if we are to determine whether the control measures presently employed are adequate.

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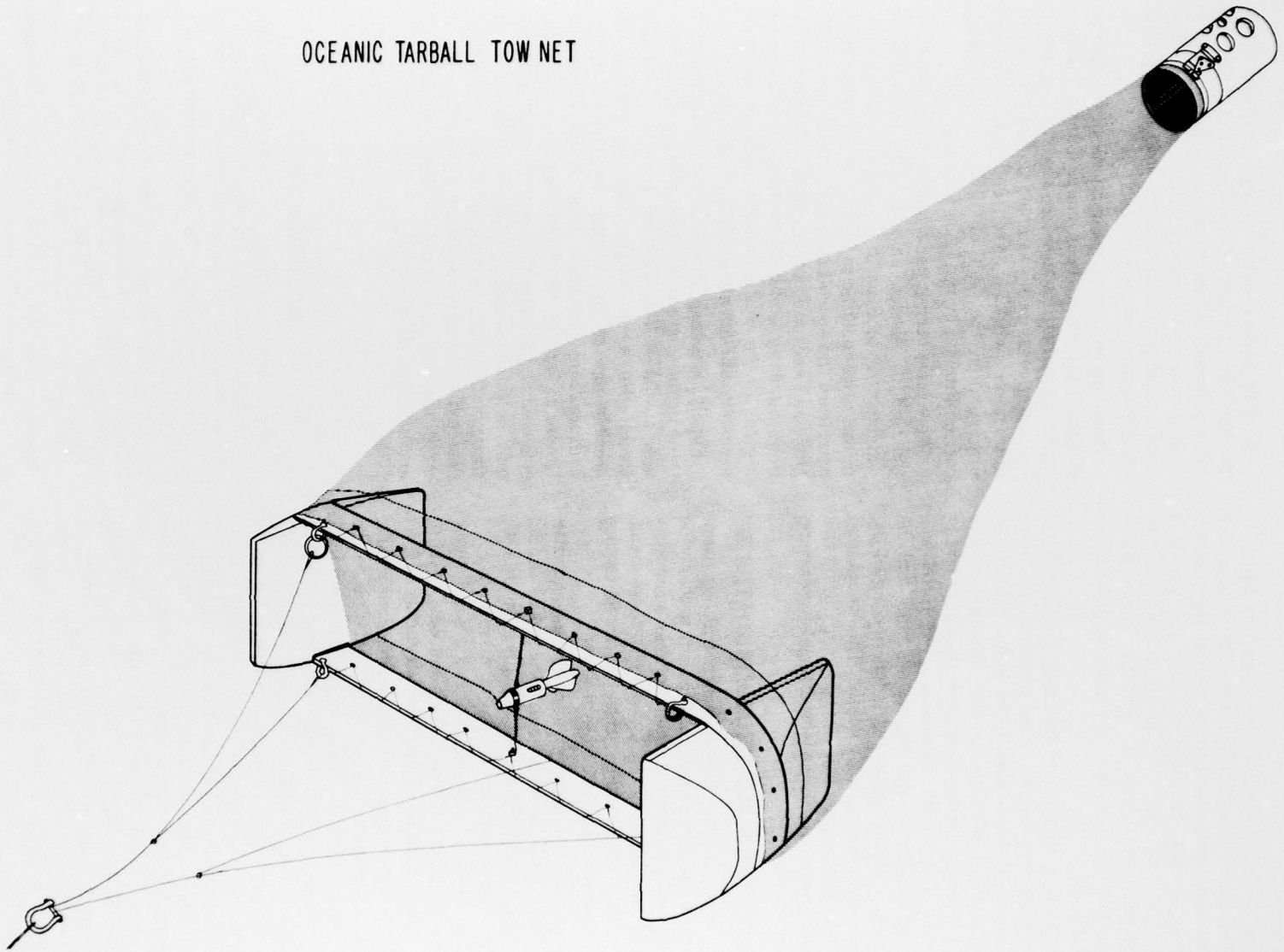

Figure 1. Tarball Tow Apparatus Used by the U.S. Coast Guard.

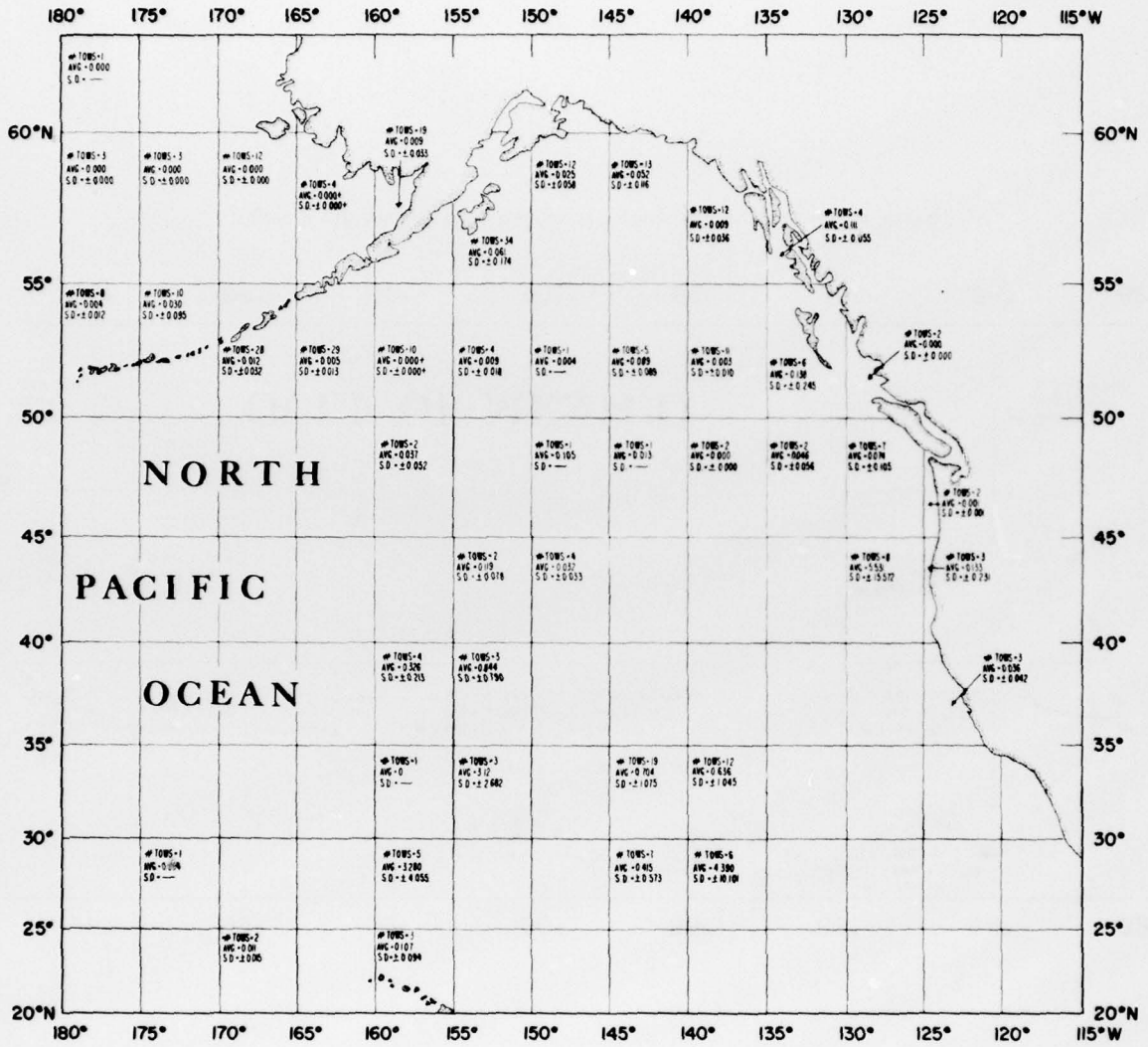

Figure 2. Distribution of Tarball Concentrations (mg/m²) in the North Pacific Ocean and Adjacent Areas.

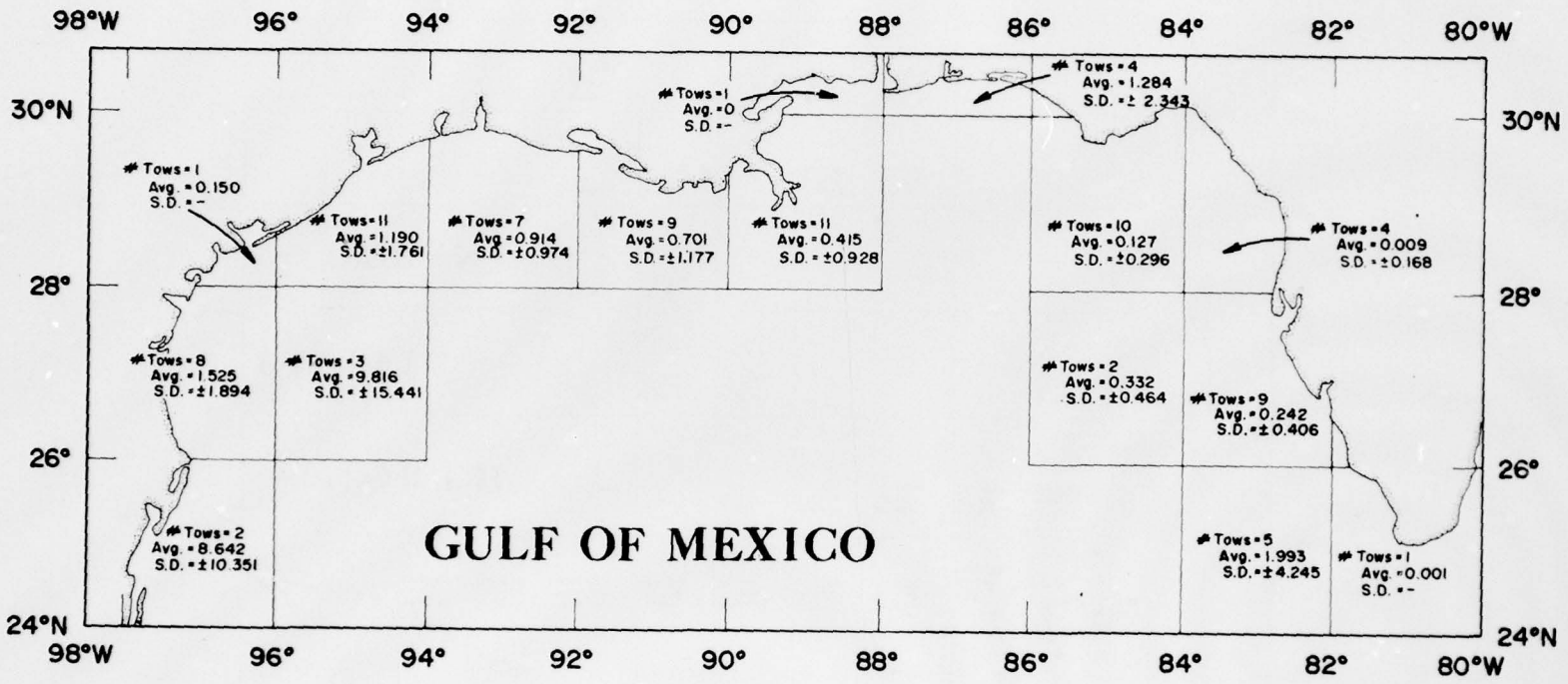

Figure 3. Distribution of Tarball Concentrations (mg/m²) in the Gulf of Mexico.

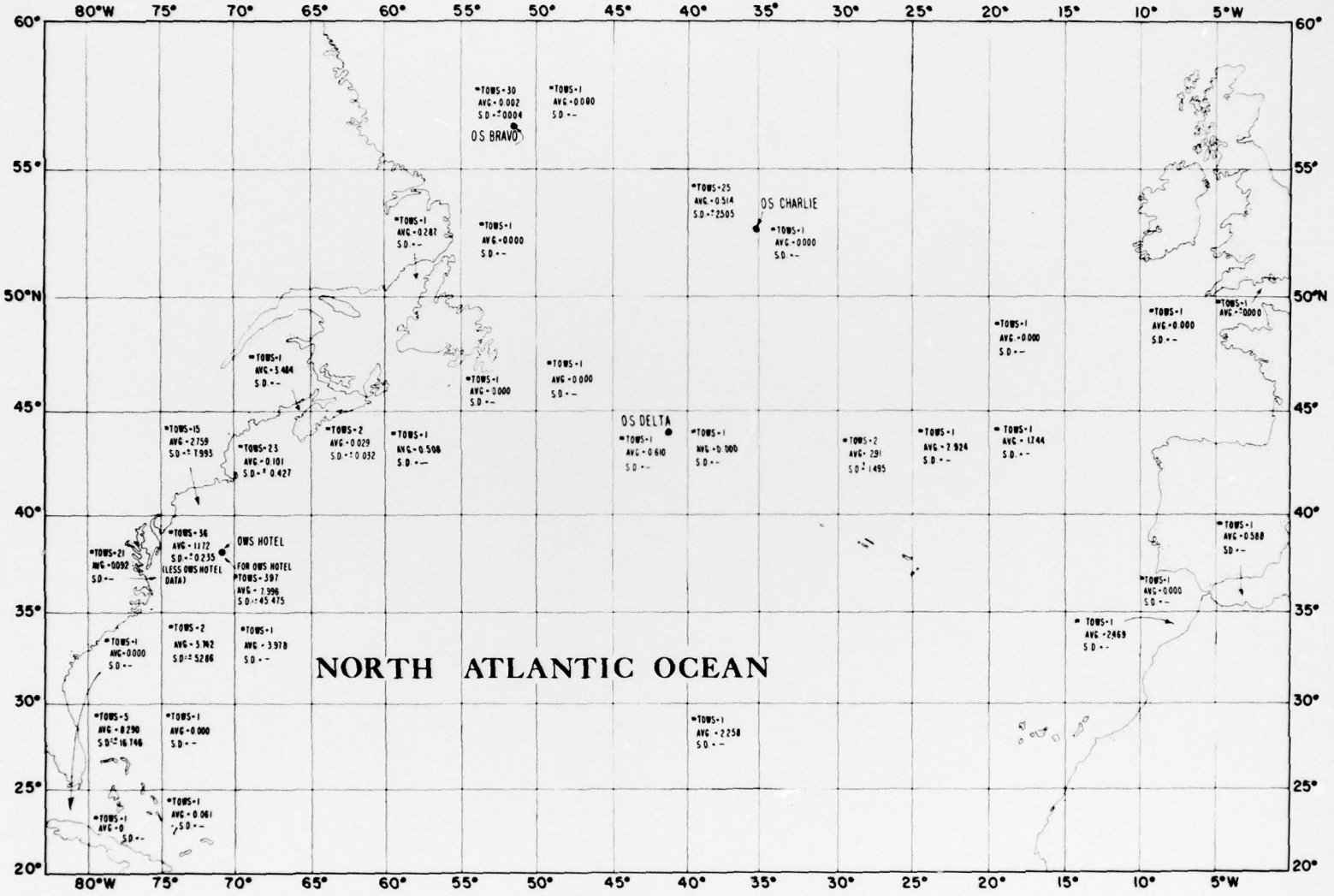

Figure 4. Distribution of Tarball Concentrations (mg/m²) in North Atlantic Ocean and Adjacent Areas.